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Amazonian phalloids: new records for Brazil and South America

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Abstract — Recent field trips in the Amazonian rainforest revealed two uncommon phalloid species, *Lysurus arachnoideus* (new for Brazil) and *Phallus cinnabarinus* (new for South America). Detailed morphological descriptions, photos, and taxonomic remarks are presented.

Key words — gasteroid fungi, *Lysuraceae,* Neotropics, new records, *Phallaceae*

Introduction

Corda (1842) proposed the family *Lysuraceae* (as "Lysuroidea") when he segregated the genera *Lysurus* Fr. and *Aseroe* Labill. from *Clathraceae.* Though many authors did not accept *Lysuraceae* (Cunningham 1944, Zeller 1949, Dring 1980), Hosaka et al. (2006) showed that *Lysuraceae* is phylogenetically more closely related to *Phallaceae* than to *Clathraceae,* and considered it an independent family, comprising the single genus *Lysurus* Fr., originally proposed to accommodate *L. mokusin* (Fries 1823).

Kirk et al. (2008) accept five species in *Lysurus,* although Index Fungorum lists 41 names for the genus. Diagnostic morphological features for *Lysurus* include a long stipe with a distinct fertile portion consisting of arms or vertical columns that are united or free or that form a network and a gleba lying on the inner surface of each arm or column (Dring 1980, Trierveiler-Pereira et al. 2014).

The genus *Phallus* Junius ex L. includes species recognized by their phallic shape that comprises an immature basidioma enclosed in a volva that breaks

with maturity and from which emerges a pseudostipe with a fetid mucilaginous gleba. *Phallus* species are widely distributed, but Kreisel (1996) indicated that the center of diversity is China and Southeast Asia.

Thirteen *Phallus* records and five *Lysurus* species are currently recognized from Brazil (Trierveiler-Pereira & Baseia 2009, Cortez et al. 2011); some doubtful taxa have also been reported. This paper contributes to the taxonomic knowledge of phalloid diversity in Amazonia.

Materials & methods

The specimens were collected during field trips in Brazilian Amazonian rainforests (Careiro, state of Amazonas, Brazil) and French Guiana (Cayenne), where ecological notes and photographs were taken. Morphological measurements were taken from fresh and dried specimens according to Dring (1980) and Cortez et al. (2011). Color descriptions follow Kueppers (1982). Microstructures were measured after rehydration in KOH 5%, with 20 measurements made randomly for each structure using a Leica DM 2500 microscope. Spore and hyphal images were captured with a coupled EC3 camera and Leica Application suite v.2.1.0 software. The specimens were deposited at the Instituto Nacional de Pesquisas da Amazônia Herbarium, Manaus, Amazonas, Brazil (INPA).

Taxonomy

Lysurus arachnoideus (E. Fisch.) Trierv.-Per. & Hosaka, Mycologia 106: 909, 2014. Fig. 1

≡ *Aseroe arachnoidea* E. Fisch., Denkschr. Schweiz. Naturf. Ges. W.S. Lee, Mycologia 32(1): 76, 1890.

Eggs 15–20 mm diam., globose to subglobose, pale yellow (N00Y20M00), semi-hypogeous, thin rhizomorphs present. Expanded basidiomata 40 × 11 mm. Volva 27–21 mm wide, white (A00M00C00) to pale yellow (N00Y20M00), outer layer composed of filamentous hyphae 4.6–6.4 µm wide, septate with clamp connections, inner layer gelatinous, composed of 4–5.5 µm wide filamentous hyphae. Pseudostipe 12 × 11 mm, cylindrical, white (A00M00C00); surface rugose, hollow, ending in a central perforated disc; composed of globose to subglobose pseudoparenchymatous hyphae, 70 µm diam., hyaline in 5% KOH. Receptacle formed by a disc with 9 arms developing from the margins. Arms up to 18 mm long, not cylindrical, hollow and consisting of a single tube, white (A00M00C00), inner surface rugose, covered by the gleba up to 2/3 of the arm length. Gleba olive brown (N99A50M10), fetid. Basidiospores 3.5–4.4 × 2.1–2.5 µm, ellipsoid, smooth, greenish in 5% KOH.

Ecology & distribution: Hosaka (2010) reports *L. arachnoideus* from Africa, Thailand, Japan, China, Indonesia, Sri Lanka, and Malaysia.

Specimens examined — **BRAZIL. Amazonas: Careiro,** Purupuru community, 3°22.96′S 59°42.63′W, in dung, in an ombrophilous dense forest fragment, 7.II.2013, T.S.

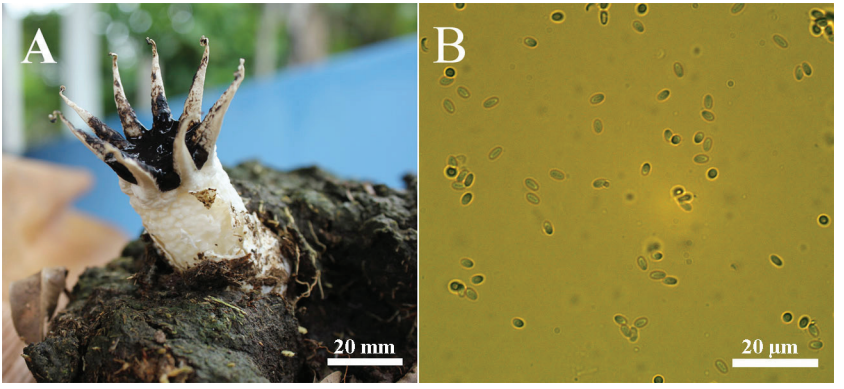

Figure 1. *Lysurus arachnoideus* (INPA 256537). A: Expanded basidioma. B: Basidiospores.

Cabral 41 (INPA 256537; Genbank KJ764820). **JAPAN. Tottori: Kokoje,** 1.IX.1980, T. Hongo & E. Nagasawa (TMI 6927); 5.IX.1980, E. Nagasawa (TMI 6929); 9.IX.1980, E. Nagasawa (TMI 6930); 22.IX.1983, I. Arita (TMI 11622).

Comments — *Lysurus arachnoideus* sensu lato was previously recorded only once from South America, by Fischer (1928), who described a new variety (*Aseroe arachnoidea* var. *americana*) based on a specimen collected in Suriname, which apparently differed from *A. arachnoidea* var. *arachnoidea* mainly by the arms being arranged in pairs. Unfortunately Fischer (1928) did not provide a detailed description or include microstructure sizes. Our specimen has unpaired arms (Fig. 1A), and the spore size matches an African specimen described by Dring (1964). The taxonomically significant characters do not vary significantly between the Brazilian and the Japanese specimens. The Japanese material has a pseudostipe and arms longer than the Brazilian specimen, pseudoparenchymatous hyphae that are up to 76 µm diam., and smooth spores that are up to 4 µm long. Despite these differences, we prefer to maintain our collection as *L. arachnoideus* (instead of *A. arachnoidea* var. *americana* E. Fisch.) based on the morphological characters until further molecular analyses can be carried out.

Our Amazonas specimen represents the second record for South America and the first for Brazil.

Phallus cinnabarinus (W.S. Lee) Kreisel, Czech Mycol. 48: 278, 1996. Fig. 2

≡ *Dictyophora cinnabarina* W.S. Lee, *Mycologia* 49: 156, 1957.

Eggs 24–23 mm wide, ovoid to subglobose, pale yellow (N10A10M00) to brown (N60A90M00), with thick and lilac to pink rhizomorphs. Expanded basidiomata 192 mm high. Receptacle 34 high × 70 mm wide, bright orange (N10A70M70), campanulate, with an apical pore, surface reticulate.

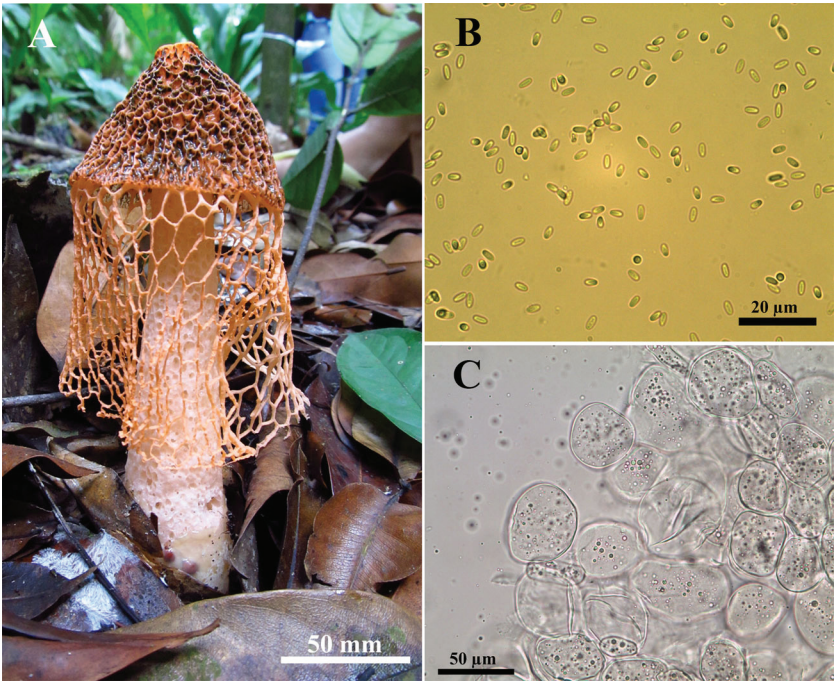

Figure 2. *Phallus cinnabarinus* (INPA 255835). A: Expanded basidioma. B: Basidiospores. C: Pseudoparenchymatous hyphae of pseudostipe with pinkish pigment droplets.

Pseudostipe 130 × 23 mm, cylindrical, spongy, pale pink (N10A40M30), composed of globose to subglobose pseudoparenchymatous hyphae, 40–67 µm diam., hyaline in 5% KOH, pinkish pigment droplets present. Volva pale yellow (N10A10M00), outer layer cottony, composed of filamentous hyphae 3–4 µm diam., sinuous, septate, clamp connection present; inner layer gelatinous, composed of filamentous hyphae 2.2–3 µm diam., hyaline in KOH 5%; basal portion with rhizomorphs. Indusium extending to half of pseudostipe, bright orange (N10A80M50), 69 mm long, polygonal meshes up to 9 mm, formed of globose to subglobose hyphae, 24–66 µm diam., pinkish pigment droplets present. Gleba brown (N60A90M40), mucilaginous. Basidiospores 2.8–4.2 × 1.2–1.9 µm, ellipsoid, smooth, olive brown in 5% KOH.

Ecology & distribution — Kreisel (1996) first described *Phallus cinnabarinus* from Taiwan (Kreisel 1996), but it has since been reported from many parts of the world (Hemmes & Desjardin 2009).

Specimens examined — **BRAZIL, Pará: Belém,** Jardim Botânico Bosque Rodrigues Alves, 1°25.83′S 48°27.30′W, on soil among grasses and at the base of bamboo clumps, 27.XI.2013, T.S. Cabral 81 (INPA 255835; Genbank KJ764821); Museu Paraense Emílio

Goeldi, 1°27.55′S 48°28.60′W, 28.XI.2013, T.S. Cabral 82 (INPA 255836). **FRENCH GUIANA: Cayenne,** in grounds of the Herbier de Guyane (CAY), Institut de Recherche pour le Developpement (IRD), 4°56.35′N 52°17.21′W, 11.III.2013, Cabral TS 48 (INPA 255837).

Comments — There is controversy involving two morphologically similar *Phallus* species: *P. multicolor* (Berk. & Broome) Cooke and *P. cinnabarinus*. *Phallus multicolor* [≡ *Dictyophora multicolor* Berk. & Broome] was originally described as having a lemon-yellow indusium, an orange receptacle, and spores up to 5 µm (Berkeley & Broome 1883), while *P. cinnabarinus* was described with a cinnabar-red receptacle and indusium, volva with pinkish rhizomorphs at base, and spores up to 4 µm (Lee 1957). Considering the original descriptions, we believe that the specimens analysed here represent *P. cinnabarinus*, based mainly on the cinnabar-red color of the indusium and receptacle, spores smaller than in *P. multicolor*, and divergence in rhizomorph colours. Cunningham (1944) described an Australian specimen of *Phallus multicolor*, mentioning a salmon-pink indusium, orange receptacle, volva with short soft spines, and basidiospores up to 4.5 µm long. Reporting *P. multicolor* from India, Dutta et al. (2012) cited a lemon-yellow indusium, lemon-yellow to yellowish orange receptacle, and different basidiospore size. Although Hemmes & Desjardin (2009) provide good photos of both species that illustrate the primary macroscopic differences (indusium and receptacle colours) between the two species, unfortunately, a detailed description of *P. multicolor* cannot be found in the recent literature.

There is no previous record of *P. cinnabarinus* for South America. Cheype (2010) reported *P.* aff. *multicolor* from French Guiana, but he does not mention a herbarium voucher, which prevents further comparative analysis. A *Phallus* specimen collected on a recent field trip to French Guiana enabled a comparative study that confirmed the conspecificity of the French Guianan and Brazilian collections as *P. cinnabarinus*.

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